REPORT DOCUMENTATION PAGE

Form Approved
OMB NO. 0704-0188

1. AGENCY USE ONLY (Leave Blank)

2. REPORT DATE
31 October 2001

3. REPORT TYPE AND DATES COVERED
Final report ~~– 4/15/97 - 8/31/01~~
15Jul97-14Jul01

4. TITLE AND SUBTITLE
Dark States and deBroglie Wave Optics

5. FUNDING NUMBERS
DAAG 5597 1~~0322~~
0332

6. AUTHOR(S)
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Research Foundation of the State of New York
Office of Research Services
SUNY, Stony Brook, NY 11794-3366

8. PERFORMING ORGANIZATION
REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U. S. Army Research Office
P.O. Box 12211
Research Triangle Park, NC 27709-2211

10. SPONSORING / MONITORING
AGENCY REPORT NUMBER
P-36413-PH
.2

11. SUPPLEMENTARY NOTES
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13. ABSTRACT (Maximum 200 words)

The main thrust of this project is experiments with metastable helium atoms (He*) in dark states, entangled states, and other kinds of superpositions of motional and internal states. Also, the control of their motion by strong optical forces, exploiting non-monochromatic light. During the grant period we have made considerable progress toward these goals. Several experiments have worked, five doctoral theses have been completed, and a number of papers and conference proceedings have resulted.

20020125 293

14. SUBJECT TERMS
Dark States, deBroglie Wave Optics, Optical Forces on Atoms

15. NUMBER OF PAGES
13

16. PRICE CODE

17. SECURITY CLASSIFICATION OR REPORT	18. SECURITY CLASSIFICATION ON THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev.2-89)
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SUBMITTED FOR PUBLICATION TO (applicable only if report is manuscript):

Sincerely,

Harold Metcalf
Professor of Physics and
Distinguished Teaching Professor

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Final Report on Grant number 36413-PH (local # 0942A, Oracle #007401)

This grant terminated on 14 July, 2001, after a one-year, no-cost extension. The research performed under this grant is being continued under a new one, 41369-PH, that began on 28 August, 2000. Since a rather complete report was filed in April, 2001, just a few months before the termination, much of the material herein is repetitious. However, the publications and abstracts have been brought up to date, and there has been considerabl progress in the helium slowing as well.

A. Bichromatic Force Measurements in Rb

In 1999 and 2000 we published two papers describing our series of careful measurements of the bichromatic force to 5% accuracy [1,2]. We deflected a thermal beam of Rb using a standing wave of circularly polarized light whose components had carefully chosen relative phases, amplitudes, and frequency differences. Circularly polarized light allows the production of a pseudo-two-level atom on a $J \rightarrow J+1$ transition. Beam deflection allows accurate force measurements because both the interaction time and deflection angle are readily measured. Our results show the extremely large magnitude and velocity range of the force, and also show that its velocity dependence near the edge of the range is suitable for atomic beam slowing and laser cooling. The repetitive momentum transfer of this coherently controlled process enables a force that is very much larger than the usual maximum radiative force $F_{rad} \equiv \hbar k\gamma/2$.

B. Velocity Selective Coherent Population Trapping (VSCPT) in Two Level Atoms

In 2000 we published our unequivocal demonstration of VSCPT in two-level atoms using our $\lambda = 389$ nm light in triplet metastable helium (He*) [3]. Although initially controversial, it is now generally accepted that we have succeeded with this. The two level system is produced using circularly polarized light to drive the $2^3S_1 \rightarrow 3^3P_2$ transition ($J = 1 \rightarrow 2$). This most primitive case of VSCPT exposes its simple nature as a special kind of quantum interference, and demonstrates its presence in a system with no truly dark state. It is observable for this particular near-uv transition because the ratio of the recoil frequency to the natural linewidth is $\varepsilon \equiv \omega_r/\gamma \sim 0.22$, two orders of magnitude larger than for typical laser cooling experiments. We performed numerous tests, varying the laser parameters and an applied $\vec{B}$ field in various directions, to confirm our model of two-level atom VSCPT. In December, 2001 (after the expiration of the grant) Jeff Hack defended his Ph.D. thesis on this topic.

C. Optical Pumping of He*

In 2000 we published a description of a new scheme for optical pumping of He*, with a possible application to the nuclear alignment of ^{3}He [4]. Because of the very high gain of our fiber amplifier [5], we digressed to demonstrate this highly efficient pumping scheme in a discharge cell. We employed a very clever trick developed in the early days of lasers (1960's) to make a controllably-broad spectral output from the narrow-band laser. This frequency-shifted feedback technique involves an acousto-optical modulator whose diffracted and frequency-shifted output was fed back into the gain medium. It worked only because of the very high optical gain of our fiber, which was the property that attracted us to it in the first place.

D. Demonstration of Bichromatic Force on He*

In 2001 we published a paper describing observation of the bichromatic force on He* using our cryogenic atomic beam source and optical fiber amplifiers to produce the required high power light [6]. These experiments are intended to improve He* trapping capabilities because the slowing length L is more than 3.5 m [7] for a discharge source of typical kinetic temperature $T = 600$ K using the radiative force whose maximum value is F_{rad}. Even for a LN_2-cooled source whose characteristic kinetic temperature is $T \sim 150$ K, L is nearly 1 m. But the bichromatic force can slow such 1000 m/s atoms in a distance less than 1 cm, and thus there can be much smaller loss of atoms from angular dispersion and diffusive heating.

We implemented the bichromatic force on He* by driving the $2^3S_1 \rightarrow 2^3P_2$ transition at $\lambda =$1083 nm using amplified light that originates from an external cavity-stabilized SDL-6702-H1 diode laser. The the diode

laser frequency was locked to atomic resonance by saturated absorption spectroscopy. The light double-passed a 75 MHz AOM that was operated at 50% efficiency to make four frequencies [1,2]. One of the two emerging beams had frequency components shifted by $\pm\delta \sim \pm 75$ MHz $\sim \pm 45\ \gamma$. This beam was injected into a diode-pumped fiber amplifier to produce several hundred mW of bichromatic light. The counterpropagating laser beams crossed the atomic beam perpendicularly.

We then performed preliminary deceleration experiments using the bichromatic force at a small angle to the atomic velocities. With the AOM's we had at that time, we could expect only a small deceleration of $\sim$ 100 m/s. We used two diode laser/AOM combinations to make a total of four frequencies in the lab frame that became two frequencies detuned from resonance by $\pm\delta = \pm 75$ MHz when Doppler shifted into the atomic rest frame at $v \sim 950$ m/s [1,2]. The velocity range that can be covered by this value of δ is $\Delta v = 4\delta/3k \sim 110$ m/s. These beams were injected into two fiber amplifiers whose output beams were aligned to produce a force at a small angle (3^0) to the velocities of the He* atoms. Since the atoms pass through the laser beam at such a small angle, it was not expanded because the interaction length in the 1.5 mm beam waist was 20 mm, consistent with achieving $\Delta v \sim 110$ m/s with $F \approx 11F_{rad}$.

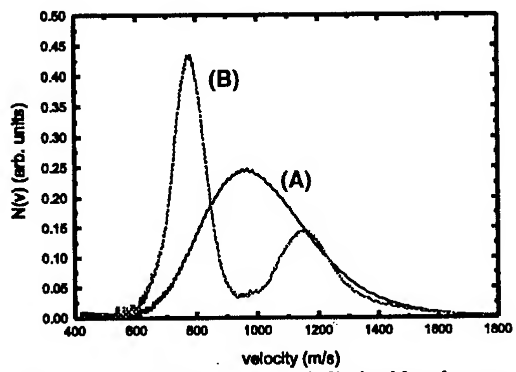

FIG. 1. The measurable force is limited by the geometry of this experiment to be $\sim 10F_{rad}$, but we believe it to be closer to $\sim 50F_{rad}$. Curve A shows the velocity distribution measured by transforming the TOF signal directly from the source. Curve B shows the distribution with a bichromatic cooling force whose parameters correspond to $\Delta v \sim 300$ m/s. The slow atoms appear as a peak in the velocity distribution almost completely outside the residual velocity distribution of unslowed atoms.

We used a time-of-flight (TOF) detector apparatus to observe such decelerations that were described in the April interim report. The slowed atoms appeared on the TOF signal as a shoulder delayed by $\sim 75\ \mu$s. As a check on this, we also changed the relative phase of the bichromatic fields and observed acceleration of the atoms by the same amount. Because the deceleration is at an angle to the atomic beam axis, we expect the slowed atoms to also be deflected out of the beam. With the imaging detector we were able to observe atoms deflected by $\sim$ 2.5 mm out of the main beam over their 50 cm flight path (also corresponding to a longitudinal velocity change of $\sim$ 100 m/s).

More recently we obtained higher frequency AOM's (400 MHz) and used these in a similar TOF experiment, and as before, we transformed the TOF signal to extract the atomic velocity distribution. We also made several changes to the geometry and alignment characteristics to have better control of the angles and beam positions. The dramatic results in Fig. 1 show He* atoms slowed up to $\sim$275 m/s and cooled by a factor of $\sim$20. All atoms with velocities between 975 and 725 m/s have been swept into a narrow peak centered at 700 m/s (curve B). They appear as a peak in the velocity distribution almost completely outside the residual velocity distribution of unslowed atoms.

E. Velocity Selective Resonances and Dark States

We have discovered a new kind of dark state, related to VSCPT, but for atoms moving at relatively high speeds in applied dc magnetic fields. The velocity-selective resonances (vsr) discovered several years ago are produced by laser cooling in a magnetic field B, and are centered at a velocity $v_{vsr} = \mu_B g B/\hbar k = \omega_Z/k$ instead of $v = 0$ [8]. Here ω_Z is the Zeeman shift of each internal level. These vsr left two tantalizing questions concerning 1) the origin of the force that produced them and 2) the limit of the cooling from this force [9]. Our recent measurements show that this limit is below the recoil energy, and numerical calculations confirm the result [10]. Such narrow widths cannot derive from optical damping forces [7] and therefore must arise another way. We attribute them to a family of quasi-dark states that are related to VSCPT states [11].

The key to the narrow widths arises from the ground state coherence produced by stimulated Raman transitions that connect two momentum states. Since the eigenstates of the system are the symmetric and

anti-symmetric superpositions of the coupled momentum states, then as described in Ref's. [3,7], one of these is a dark state. If the connected states are also degenerate, then the dark state formed by their superposition is stationary, and atoms that fall into it stay trapped there. The key point is that the energies must include the kinetic energy as well as the Zeeman energy. Thus degeneracy for two states $|1\rangle$ and $|2\rangle$ can mean $Mv_1^2/2 + g\mu_B B = Mv_2^2/2 - g\mu_B B$ or $\bar{v} = v_{CM} = \omega_Z/k$. Thus an applied $\vec{B}$-field should shift a VSCPT signal in momentum space, and this has been well established [11].

What has been missing in the picture connecting vsr and VSCPT has been the understanding that there are two independent time scales associated with the creation of the superposition of ground momentum states. One is the optical pumping time for the strongly-coupled superposition state to be emptied and the other is the leakage time out of the weakly-coupled state that would be dark and trapped in the ideal case, such as that of Ref. [12]. These notions have only recently been exposed in the 2000 thesis of Liang Liu [11] that was built on the previous work of Mary-Jo Bellanca [10].

F. Optical Forces in Frequency-Modulated Light

As part of our ongoing exploration of optical forces in non-monochromatic light [1,2,6], we have found a new implementation of a rectified dipole force that is not limited to F_{rad} and whose damping capability extends over a somewhat larger velocity range [13]. This new kind of rectified force differs from many other previously published descriptions in fundamental ways. We use light tuned well away from resonance, with weak frequency modulation chosen to put one of the sidebands close to resonance. (We ignore the second sideband because it's weak and very far from resonance.)

This modulated beam is retroreflected to form standing waves, so we consider a two-level atom in two optical standing waves of different frequencies. The "carrier" frequency produces a strong light shift and dipole force, while the weak "sideband" causes optical pumping between the dressed states of a two-level atom that have opposite light shifts. The relative spatial phase of the two standing waves is chosen so that atoms climb (descend) potential hills shifts more often than they descend (climb). We have used it for both deflection and cooling of our He* atomic beam. Figure 2 shows the deflected beam from the new rectified dipole force. Although it resembles Fig. 3 of Ref. [6], it is genuinely different in origin.

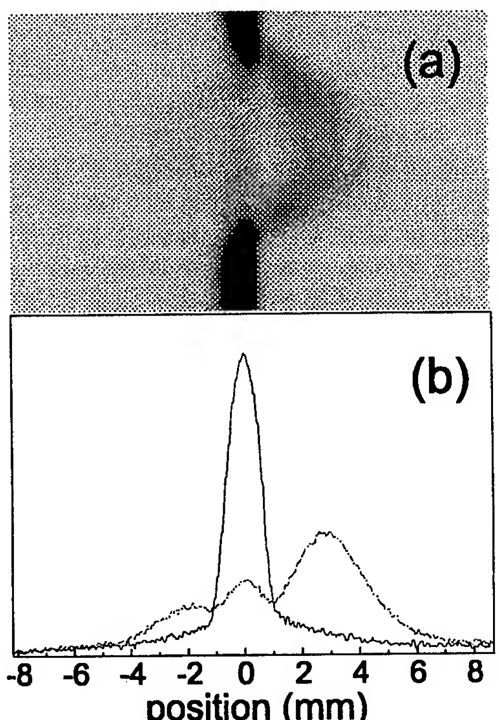

FIG. 2. The deflected beam from the new rectified dipole force. The laser parameters are detuning = 36.2γ and -2.5γ and Rabi frequency = 23γ and 3γ for the carrier and sideband respectively. The small undeflected peak in the center arises from light emanating from the source discharge, and not atoms that failed to see the light. The smaller peak to the left is caused by atoms whose initial velocity was too high to the left to be captured by the force.

We have developed an intuitive model of the origin of this large force that agrees qualitatively with our measurements, and a numerical model based on an approximation to the doubly dressed states that agrees quantitatively. Although this approximate model is based on the stationary solutions of the atom+laser Hamiltonian, comparison with our measurements shows quite excellent quantitative agreement. In collaboration with Leonid Yatsenko from the Ukraine Academy of Sciences, we are working on a more formal theory of atoms moving in a frequency-modulated field. This has now been published in Phys. Rev. A [13].

G. Stimulated Optical Compton Scattering (SOCS)

We have extended some earlier work on velocimetry of a laser cooled vapor [14] by implementing SOCS on the much sparser sample of atoms in an atomic beam. Usually transverse velocimetry is done by measuring the spatial distribution of the atoms at the end of the beam line, so good velocity resolution requires a long beam line and narrow beam-defining slits. By contrast, SOCS replaces this cumbersome scheme by direct velocimetry, thereby reducing the length of the atomic beam apparatus, eliminating the instrumental broadening caused by the longitudinal velocity spread, and removing the need for narrow slits that are required to maintain the spatial resolution [15]. Furthermore, a small extension of SOCS allows measurement of velocity components in two or three dimensions.

The basic principle underlying SOCS is identical to that of the Compton effect. For stimulated processes, where light is transferred from one laser beam to another, there is only the atomic motion, including its recoil, as the unconstrained experimental variable. Measuring absorption or gain allows determination of the initial atomic velocity to accuracy on the order of $v_r \equiv \hbar k/M$. The symmetry of the transition is broken through a non-uniform population of atomic momentum states. Therefore the intensity dependence of either beam on the detuning between them maps out the atomic velocity distribution on a sub-recoil scale. This work constitutes the Ph.D. thesis of Felix Chi that was defended on 11 April, 2001 (Felix is the first black Ph.D. from my lab). Our paper on this subject has now been published in A Phys. Rev. A [15].

H. Demonstration of Adiabatic Rapid Passage

Although bichromatic light, with its appealing π-pulse model of coherent transfer of atoms between ground and excited states is quite attractive, it is not the only way to accomplish the transfer. Adiabatic rapid passage (ARP) produced by light whose frequency is swept through resonance, is a very robust way to invert the population of two-level atoms. By the right choice of relative sweep phase in counterpropagating beams, ARP can also cause coherent exchange of momentum between atoms and field, and thus can produce a force that is very much larger than F_{rad} [16]. To test this, we have used an EOM to sweep the frequency of our light beams through resonance, and have indeed observed forces that are many times larger than F_{rad} [17]. We now have more degrees of freedom (sweep rate, sweep range, center frequency, Rabi frequency, relative phase, etc.) and varying these has led to some unexpected laser cooling effects as well. Although these experiments are somewhat prelimnary, we were invited to submit a paper to the British Journal of Optics B, Quantum and Semiclassical Optics, and it has now been accepted [18].

I. Educating Our Students

Our Ph.D. program has led its alumni into excellent starts on careers as professional physicists. In addition, we have provided research opportunities for numerous Masters students, undergraduates, and high school students whose names are listed in the charts below. These students take part in the daily life of our active research group, and thereby learn how things really work. All of our students enjoy our broad weekly seminar in atomic physics (sample calendars begin on page 8) in many of which they give talks about their own work thus providing experience in presenting talks. The textbook written in collaboration with former post-doc Peter van der Straten has been published and received many excellent reviews both in the US [19] and internationally, and has been widely complimented in private communications.

1. Graduate Students: During the past three years, five students have completed their Ph.D. theses. They have all found excellent positions in industry or academia, and are continuing their careers as profesional physicists. The subject of their research and their dates of Ph.D completion are in a chart below. Further information about their work can be found in the several publications that result therefrom. The details of their work are available in their theses.

2. Laser Teaching Center: In the summer of 1999 our department opened a new facility built completely from industrial and private funds (the PI is its founder and director). It has a suite of four well-equipped and furnished laboratories totaling over 120 m^2. The PI has also obtained University support for its operation with a full-time, Ph.D. instructor and \$30k/yr for supplies and equipment. Many of its high school alumni (even from years past) are now in college, four of whom have won Westinghouse/Intel finalist or semifinalist prizes in the past three years. Often these younger students work along with our graduate students on their various projects. Many of our undergraduates have gone off to graduate school or industrial jobs with

considerable experience in a research environment. Our undergraduates are brought to us via the University's URECA program, and NSF's REU and RAIRE programs (Stony Brook is one of 10 NSF RAIRE institutions and the PI is an active participant). Information about this very exciting and innovative facility at Stony Brook can be found at http://resonator.physics.sunysb.edu/laser/. The table below summarizes the activities of our students in the summer of 2000.

Name	School	Project
Salvador Barra	Ward Melville High School	Laser Speckle
Dhruv Bansal	Wheatley High School	Angular Properties of Fiber Bundles
David Eppenstein	Scarsdale High School	Optical Tweezers
Karl Fey	Vestal High School	Holography
Andrew Koller	Brien McMahon High School	Faraday Effect in YIG
Victor Kim	Stony Brook	Longitudinal Modes of a HeNe Laser
Petr Liska[1]	Bridgewater State College	Saturated Absorption Spectroscopy
Michael Polyakov	Ward Melville High School	Non-invasive Measure of Blood Oxygenation
Rachel Ruch[2]	San Francisco State College	Sonoluminescence
Alia Sabur[3]	Stony Brook	Angular Properties of Fiber Bundles
Tina Shih[4]	M.I.T.	Frequency Doubling with Periodically Poled $LiNbO_3$
Chris Wottawa	King's Park High School	Properties of PZT's

1. Petr (correct spelling) will transport his setup to Bridgewater State in the fall.
2. Rachel has passed the SL torch to Christine Hung who worked with her toward the end of the summer.
3. Alia is an 11-year old prodigy who has aced the introductory physics courses here at Stony Brook.
4. Tina worked with visitor R. Wynands from Univ. Bonn, and has been invited there for next summer.
5. There are presently three undergraduates working on full time projects, one on holography, one on interferometry with an eye toward studying "welcher weg" ideas, and one on fiber optics.

The newer table below summarizes the activities of our students in the summer of 2001.

Name	School	Project
Peter Amendola	Kings Park High School	Optical tweezers
Bob Azmoun	University at Stony Brook	Rubidium spectroscopy
Molly Bright	Bayport - Blue Point HS	Mueller matrix imaging
Doug Broege	University at Stony Brook	Holography
Noah Corwin	Syosset High School	Computer Generated Holograms
Jon Fuchs	Scarsdale High School	Image processing
Rohit Gupta	South Side High School	Birefringence in nanocomposites
Jose Mawyin	University at Stony Brook	Quantum optics
Guy Sisali	University at Stony Brook	Hollow laser beams
Paul Tchertchian	St.Francis Preparatory School	Optical tweezers
Fernando Ziegler	Univ. Texas at Austin	Sonoluminescence

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10. "Evolution of Coherent Dark States" (with L. Liu, and M. J. Bellanca), accepted by Phys. Rev. **A**.

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1. "Optical Nanofabrication", (with M. Mützel, D. Haubrich, and D. Mescehede) in preparation.
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11. L. Liu, M.J. Bellanca, M. Cashen, L. Yatsenko, and H. Metcalf, "Unexpected Effects of Magnetic Fields on VSCPT", Abstracts of ICAP XVII, Florence (2000) D.27.

12. "Laser Cooling of Metastable Helium by Velocity Selective Coherent Population Trapping in the Presence of Magnetic Fields", (with C. Affolderbach and O. Kritsun), abstracts of the Spring meeting of the German Physical Society, Berlin, April, 2001.

13. "Velocity Selective Raman Resonances at High Recoil", (with O. Kritsun and C. Affolderbach) Bull. Am. Phys. Soc. **46**, No. 3, 99 (2001) S5-20.

14. "Transverse Atomic Beam Velocimetry", (with F. Chi and M. Partlow), Bull. Am. Phys. Soc. **46**, No. 3, 98 (2001) S5-16.

15. "Velocity Selective Coherences in a Magnetic Field," (with L. Liu and M. Cashen), Bull. Am. Phys. Soc. **46**, No. 3, 99 (2001) S5-17.

16. "Bichromatic Sisyphus Cooling", (with M. Cashen), Bull. Am. Phys. Soc. **46**, No. 3, 99 (2001) S5-18.

17. "Coherent Exchange of Momentum between Atoms and Light", (with M. Cashen and L. Yatsenko), Bull. Am. Phys. Soc. **46**, No. 3, 99 (2001) S5-19.

18. "Optical Forces in Polychromatic Light Fields", (with M. Cashen, O. Rivoire, and L. Yatsenko), Opt. Soc. Am. Annual Meeting, Long Beach, CA, Oct. 2001, TuF1.

PROJECT PERSONNEL

Research Professor

Prof. Thomas Bergeman

Former Ph.D. Students

Name	Degree Date	Present Occupation
Martin Williams	May 1999	Corning Fiber Division
Mary-Jo Bellanca	August 1999	Univ. Konstanz, Germany
Liang Liu	December 2000	Lightpath Technologies
Felix Chi	April 2001	Corvis Corp.
Jeff Hack	Dec 2001	Southern Co.

Former Masters Student

Name	Degree Date	Present Occupation
Carlos Avila	December 1998	Fibertek Inc

Present Ph.D. Students

Name	Thesis Project
Matt Partlow	Quantum Effects in Momentum Transfer in Rubidium
Oleg Kritsun	STIRAP Excitation of Rydberg States of Helium
Matt Cashen	Polychromatic Optical Forces on Helium
Xiyue Miao	Production of Rydberg states of Helium
Seung Hyun Lee	nothing selected yet

Visiting Students

Name	Home Institution	Duration	Date
Serge Florens	École Normale Supérieure, Paris	6 months	1998
Michiel van Rijnbach	University of Utrecht, Netherlands	2 months	1998
Vincent Bretin	École Normale Supérieure, Paris	6 months	1999
Christoph Affolderbach	Inst. Angewandte Physik, Bonn	5 months	2000-2001
Olivier Rivoire	École Normale Supérieure, Paris	6 months	2001

Senior Visitors

Name	Home Institution	Duration	Date
Prof. Maxim Olshanii	Harvard Univ (now at U.S.C.)	3 months	1999
Dr. Robert Wynands	Inst. Angewandte Physik, Bonn	4 weeks	2000
Dr. Leonid Yatsenko	Ukrainian Academy of Sciences	6 weeks total, multiple visits	2000, 2001

Seminars in Atomic, Molecular and Optical Physics, Spring 2000

Jan. 31, 4:00 PM, Steve Gensemer, University of Connecticut, Storrs: "Characterization and Contol of Cold Atom Collisions"

Feb. 7, 4:00 PM: Prof. Victor Flambaum, University of New South Wales, Australia, "Huge Enhancement of Parity Violation in Radium and Radon Atoms"

Feb. 11, 1:00 PM, Dr. Tom Killian, N.I.S.T. (MD): "From Laser Cooled Atoms to an Ultracold Neutral Plasma"

Feb. 14, 4:00 PM: Dr. Chandra Raman, M.I.T.: "Shaking and Stirring a Quantum Gas: Light Forces and Bose-Einstein Condensates"

Feb. 21, 1:00 PM, Dr. Paola Bicchi, University of Siena, Italy, "Non-Resonant Multi-Photon Spectroscopy of ^{6}LI and ^{7}Li"

March 3, 1:00 PM, Dr. Mikhail Lukin, ITAMP, Harvard-Smithsonian, "Nonlinear Optics and Quantum Entanglement with Electromagnetically Induced Transparency"

March 6, 4:30 PM, Dr. Matt Anderson, Institute of Optics, Rochester University, "The World of Ultra-Fast Lasers: Physics at Femtosecond Time Scales"

March 10, 3:00 PM: Prof. Dima Shepelyansky, Université Paul Sabatier, Toulouse, France: "Quantum Chaos and Quantum Computers"

March 13, 4:00 PM: Dr. Jan Chaloupka, Brookhaven National Laboratory, "Observation of Electron Trapping in an Intense Laser Beam"

March 27, 4:00 PM: Prof. Nick Bigelow, University of Rochester, "Ultra-Cold Atomic Mixtures: From Cold Molecules to Two-Component Atomic BEC."

April 3, 4:00 PM: Prof. Leonid Yatsenko, Insitute of Physics, Kiev, Ukraine, "Atomic Motion Control Using Time-Dependent Laser Radiation"

April 17, 4:00 PM: Dr. Jonathan Friedman, SUSB, "Schrödinger's Cat in an RF-SQUID: A Brief Report."

April 24, 4:00 PM: Dr. Claire Lyngøa, BNL, "Characterization and Application of High-Order Harmonics."

April 28, 2:00 PM in C-133 (Joint Seminar with Nuclear Structure): Dr. Marianna Safranova, U. of Notre Dame, "Precision Calculations of

May 1, 4:00 PM, Dr. Alois Mair, University of Innsbruck, Austria, "Angular Momentum of Entangled Photons."

May 5, 3:00 PM, Stephen Selazny, S.U.S.B. (Thesis Defense): "Population Dynamics of Microwave Driven Helium Rydberg Atoms"

Seminars in Atomic, Molecular and Optical Physics, Fall 2000

Sept. 5, 4:00 PM, Prof. Yehuda Band, Ben-Gurion University, Israel, "Non-Linear Atom Optics: Four-Wave Mixing with Coherent Matter Waves"

Sept. 11, 4:30 PM: Prof. Stuart Mclaughlin, Departments of Physiology and Biophysics, Health Sciences Center, S. U. S. B., "Using Laser Tweezers to Measure Enzyme Activity"

Sept. 25, 4:30 PM: Dr. Paul Julienne, N.I.S.T (MD): "Scattering Resonances as a Key to Cold Collision Physics"

Oct. 2, 4:30 PM, Prof. Donghyun Cho, Korea University, Seoul, and N.I.S.T. (MD), "Optical Traps Using a Multi-Level Atom Model"

Oct. 16, 4:30 PM: Dr. Kai Bongs, Hannover U. Germany and Yale, "BEC: Dark Solitons and Waveguides"

Oct. 23, 4:30 PM: Dr. Gilles Nogues, E.N.S. Paris and Yale University, "Quantum Non-Demolition Detection of a Single Photon and Engineered Entanglement in Cavity QED"

Oct. 30, 4:00 PM: Jonathan Weinstein, Harvard University, "Buffer Gas Cooling and Magnetic Trapping of Atoms and Molecules"

Nov. 6, 4:00 PM, Prof. Mark Edwards, Georgia Southern University and N.I.S.T. (MD): "Optical Manipulation of a Bose-Einstein Condensate"

Nov. 7, 2:00 PM (Practice Talk) and Nov. 9, 2:00 PM: Liang Liu, S.U.S.B. (Thesis Defense): "Sub-Recoil Laser Cooling of Metastable Helium"

Nov. 13, 4:00 PM: Prof. Wonho Jhe, Seoul National University, Korea, and JILA: "Atom Optics in Hollow Optical Systems"

Nov. 17, 3:00 PM, Prof. Perry Rice, Miami University, Ohio, "Photon Statistics and Output Spectra of Single Atom Lasers"

Dec. 4, 4:00 PM, Dr. Chad Orzel, Yale University, "Squeezed States in a Bose-Einstein Condensate."

Dec. 11, 4:00 PM. Dr. Kate Kirby, Harvard Smithsonian Center for Astrophysics, "Molecule Formation in Dilute Gases: from the Early Universe and Supernova Ejecta to Bose-Einstein Condensation."

Seminars in Atomic, Molecular and Optical Physics, Spring 2001

Monday, Feb 5, 4:00 PM. Professor Siu Au Lee Department of Physics, Colorado State University "Laser Focusing of Group III Atoms"

Wednesday, Feb 7, 4:00 PM. Prof. John Webb University of New South Wales "New Results on the Time Variability of the Fine Structure Constant"

Monday, Feb 19, 4:00 PM. Dr. Gregory T. Foster Yale University "Gravity Gradiometer with Atom Interferometry; Progress Report"

Friday, Mar 2, 4:00 PM. Professor Reinhold Bluemel Wesleyan University "Exact Trace Formula for a Class of One-Dimensional Ray Splitting Systems"

Monday, Mar 19, 4:00 PM. Dr. Jan Chaloupka BNL Chemistry Department "Strong-field double ionization of rare gases"

Monday, Mar 26, 4:00 PM. Professor William K. Wooters Williams College "Quantum Entanglement as a Resource for Communication"

Monday, Apr 2, 4:00 PM. Prof. Hong Y. Ling Rowan College "Collective Atomic Recoil Laser and Matter Wave Amplification"

Wednesday, Apr 11, 1:00 PM. Felix Chi, SUSB, "Velocimetry of Cold atoms", Thesis defense.

Friday, May 4, 4:00 PM. Dr. Axel Kuhn, Max Planck Institute Garching, "Photons from Vacuum-Stimulated Raman Scattering in an Optical Cavity"

Monday, May 7, Dr. Pierre Pillet, Orsay, France, "Formation of Ultra-cold Molecules"

Tuesday, May 8, Prof. Dieter Meschede, Institut für Angewandte Physik, Bonn, "Delivery of Single Atoms on Demand"

Seminars in Atomic, Molecular and Optical Physics, Summer 2001

Monday, July 16, 2001: Dr. Gerald Gwinner, Max Planck Institute, Heidelberg, Germany: "Towards an Improved Measurement of Relativistic Time Dilation with Laser Spectroscopy of Stored Heavy Ions."

Seminars in Atomic, Molecular and Optical Physics, Fall 2001

Sept. 24: Prof. Lorenz Willmann, Groningen University, Holland, and MIT. "Ultracold Hydrogen: Recent Results from BEC Studies and Prospects for Ultraprecise Spectroscopy."

Oct. 1: Prof. Dima Shepelyansky, Universitè Paul Sabatier, Toulouse, France: "Quantum Computers Facing Chaos."

Oct. 8: Dr. David Phillips, Harvard-Smithsonian Center for Astrophysics: "Light Storage in an Atomic Vapor."

Oct. 15: Optical Society Meeting, no seminar.

Oct. 22: Dr. Linda Young, Argonne National Laboratory, "Uses and Abuses of Trapped Atoms."

Oct. 29: Dr. Wilbert Rooijakkers, Harvard University, "Magnetic Circuits for Atomic Matter Waves."

Nov. 5: Jürgen Gripp, Lucent Technologies, "Optical Packet Switch Fabric with Terabit Throughput."

Nov. 9: 2:30 PM (Note special day.). Jun Ye, JILA: "Time Meets Frequency: Coherent Optical Waveform Generation and Optical Frequency Synthesis."

Nov. 12: Jan Yarrison-Rice, Miami University, Ohio, "Viewing the World Through Nanometer Eyes."

Nov. 19: Thanksgiving recess.

Nov. 26: Robin Côté, University of Connecticut: "Ultra-cold Atom-Ion Interactions."

Nov. 30: Mary Ifferte-Stone, SB M.S.I. Program and U. of Connecticut, "Stabilized External-Cavity Diode Laser."

Dec. 3: Dr. Frank Narducci, Naval Air Warfare Center and Office of Naval Research: "From Cavity-Enhanced Laser Cooling to Coherent Storage."

Dec. 4: Dr. Martin Kamp, U. of Würzburg, Germany, "Photonoic Crystals: Optical Properties and Device Applications."

Dec. 10: Prof. Michael Chapman, Georgia Institute of Technology, "Atomic Bose-Einstein Condensation in a Laser Trap, and other Quantum Tools for Ultracold Atoms."

Dec. 11: Jeff Hack, Ph.D.Thesis Defense: "Laser Cooling in the Recoil Domain."